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The Circulatory System

Susanna Cocroft

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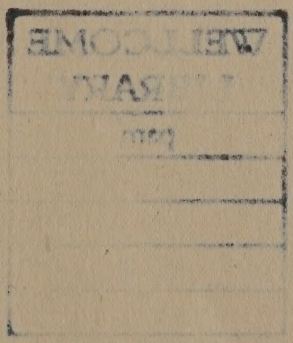

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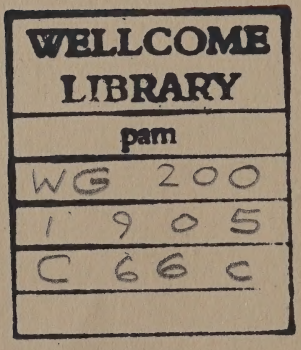

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THE CIRCULATORY SYSTEM

BY

SUSANNA COCROFT

An inviolable law of nature requires action for strength, requires movement for growth, requires unity of movement for equal strength of all parts. This is entirely true in the animal kingdom; inactivity of an organ or tissue means weakness, ultimate shriveling up of the tissue, atrophy or decay. Sluggish circulation or inadequate use of any part means incomplete growth, means disproportionate strength or disuse.

Complete freedom and uniform strength of every organ is the natural state of the human body—it is the state of perfect health—and it is the sacred duty of every human being to keep in health. The idea that sickness is sent us to "try the spirit as by fire, to chasten and to purify it," is a thought, unhealthy and unnatural. Sickness, as a rule, is simply the result of ignorance of the natural requirements, and in a large percentage of cases is caused by sluggish or disturbed circulation, occasioned by a lack of all-around exercise, and a consequent failure of the system to eliminate its waste.

To retain the body in its natural state every capillary,

every nerve and muscle tissue, and every sinew, must be kept uniformly strong; there must be a free action of each lung cell, a flexibility of every muscle and cartilage, and a corresponding strength of every nerve and brain cell. The brain, when untrammeled by bodily restrictions, is capable of an almost limitless amount of work.

The circulatory system consists of the heart, which forces the blood on its entire circuit through the body; the arteries, which convey the blood, carrying the food products from the digestive organs and oxygen from the lungs, to every tissue; the veins, which begin at the ends of the small arteries in the capillaries and return the impure blood to the heart; and the lymphatics, which begin in the spaces about the capillaries, where the nutriment is distributed to all tissues, carrying both nutriment and waste from the tissues, back into the blood.

The lungs are not properly a part of the circulatory system, but they play an important part in purifying the blood, and are, therefore, discussed with the circulation.

In tracing the circulation in the following pages, the reader should have at hand the Body Manikin [No. 2, of this series of lectures] that the various organs and the course of the blood may be clearly kept in mind. The numerals in the following pages correspond to those on the Manikin.

THE HEART: The heart has four cavities—the right auricle (25) and the left auricle (26), connected with the right (27) and left (28) ventricles by a free opening from each, called cardio-auricular openings. (See the Blood Formation, Absorption and Circulation Plate of the Body Manikin.) The right and left ventricles hold about four ounces of blood each. When the heart contracts both ventricles are emptied at the same time, and when it dilates the ventricles are both filled at the same time, each from its own auricle. The right ventricle of the heart is filled with venous blood, the left with arterial.

When the heart contracts the venous blood in the right ventricle is driven into the pulmonary artery (5), through

which it goes to the lungs, where it comes in immediate relation with the oxygen in the capillaries in the air cells, and is passed on into the pulmonary veins (17) as aerated blood, which is emptied by them into the left auricle; from the left auricle it passes into the left ventricle. When the left ventricle contracts, it drives its four or more ounces of aerated blood into the aorta (4), which is furnished with strong valves to keep each charge of blood from returning.

The heart contracts about seventy-two times per minute in all people who are in normal health. The blood makes a complete circuit of the body in a normal state in forty-five to fifty seconds, or during forty-eight heart beats.

The heart is the pump for the circulatory system, and, while the initial force of action is made in the muscular tissues of the heart, supposedly by reason of the contact of certain chemical properties of the blood with the mucous lining, the return of the blood through the veins to the heart is of utmost importance in keeping up the force of its action. The return flow through the venæ cavæ forces the right auricle open, which, in turn, forces the opening into the right ventricle, and the force of the returning blood, together with the muscular contraction of the heart, forces it out again into the pulmonary artery. It is in this return flow to the heart that the strength of muscles which lie along the course of the veins and the lymphatics plays so vital a part. Any object set in motion tends to keep in motion, and the heart of each individual born into the world is set in motion in a certain rhythm, which determines, to a degree, the rhythm of thought and of movement through life; for strong heart action its natural rhythm must not be disturbed. It works stronger in its natural rhythm, just as the brain works better in an even mental poise. Any outward influence, such as pressure of the ribs, pressure of the stomach upon the heart, interference with the action of the heart, occasioned by the condition of the nerves, or a disturbed state of mind, tends to throw the heart out of its rhythmic motion. Such influence tends to weakness.

By regularly increasing the action of the lymphatics

and veins, by massage or by regulated exercise and breathing, the return flow of blood is accelerated and the action of the heart is aided. The natural rhythmic movements of the heart and the consequent retention of the strength of the muscles about it are also aided by regulated exercise and deep breathing.

The belief that a person with a weak heart should not exercise is erroneous. The exercise should be slow and not too strenuous, until the muscle tissues and nerves of the heart be strengthened, but exercise which gradually works away impediments and unifies circulation, relieves pressure and strengthens the heart action. Clogging of the circulation at any point calls for more strength of the heart to force the blood past the obstruction. The backing up of the circulation, and the overcrowding of the arteries and valves preceding this point, tend to weaken the heart action and to produce a state known as arterial tension. All exercise occasions alternate contraction and relaxation of the muscles and the veins which lie between the muscles are thus alternately compressed and relaxed; as the muscles contract, since the valves in the veins prevent the return flow of blood, the venous circulation toward the heart is accelerated by exercise.

It will be readily seen, also, that the heart, as well as the lungs, must have adequate room for movement; upon comparing the spaces through the upper and middle zones of cuts 2 and 3 of the Body Manikin with cut 1, it will be noted that, where one stands as far out of poise as these two figures indicate, the room for action of the heart and lungs is decreased about one-half.

Much heart difficulty is caused by dilated stomachs and by weakened or "over-strenuous" nerves.* Anything, therefore, which tends to put the stomach and the nerves in a natural condition relieves the pressure or tension interfering with the heart action. In numbers of cases of both women and men, but more especially in women, the heart is so packed about with adipose tissue that it cannot

*Publishers' Note: See lecture by Miss Susanna Cocroft upon "The Nervous System."

move freely, and often degeneration of the tissues about the heart results.

The heart is not under the direct control of the will, but in the walls of the auricles and ventricles are numerous small nerve ganglia and nerve cells from the sympathetic nervous system. These control the heart, and they are wonderfully affected by thought and emotion.

Neglect in maintaining the strength of the heart and thus allowing it to get into an unstable state, results in atrophy and decay of the tissues about it. This atrophy and decay expresses itself in lack of courage and in a readiness to blush upon the mention of unpleasant topics.

Fainting, or syncope, is chiefly due to a strain or to other conditions causing a partial suspension of the heart's action, accompanied by low breathing and a loss of sensation and voluntary motion. Valvular heart difficulty, or a diseased condition of the large arteries, tends to produce this suspension of the heart's action, also. This occurs more frequently in women than in men. The heart will regain its normal action more readily by lying with the head lower than the body. Where the heart is thus vulnerable, the patient usually complains of a stuffy feeling upon entering a church, a hall or a room where the air is impure. Much palpitation and many irregularities of the heart action are due to some phase of indigestion. A full description of the causes of nervous heart cannot be given here, but emotions, worry, fright or an anæmic state of the blood will cause such. Heart palpitation frequently results from constant excessive exertion, such as violent exercise, straining at the stool, the reception of depressing news, or by irritable state of the cardiac nerves. Other irregularities of the heart accompany a deranged condition of the kidneys known as Bright's Disease.

ARTERIES: The arteries convey arterial blood to every tissue of the body for nourishment.

The aorta, which is the opening for the outflow of blood from the heart, is about an inch in diameter; it curves just

above its base to bend downward in front of the spinal column; in the pelvis it divides into two chief branches (F) (see foundation plate of the Body Manikin), one for each of the lower extremities. The great trunk between the heart and the pelvis is called the abdominal aorta (A) and gives branches to the lungs, the heart, the diaphragm, the liver, the stomach, the bowels and the pelvic organs. Other branches go out to supply the head and the upper extremities, to the framework of the body, to the muscles of the trunk and to the skin. These smaller branches, which are called arterioles, continue to branch out in the midst of the tissues until they become very minute and are then called capillaries. (The Blood, Formation, Absorption and Circulation Plate of the Body Manikin illustrates these branchings of arteries and the converging of veins and lymphatics.)

The aorta is much like the trunk of a luxurious tree, the artery branches like the limbs, the arterioles the stems of the leaves, and the capillaries may be regarded as the cells in the leaves. As the limbs of a tree grow smaller and smaller as they continue to branch, so the arteries become smaller and smaller, until the tubes are of a microscopic size when they reach the capillaries; they are the smallest part of the circulation tube, and are so small that a pin point will puncture several, being not more than one-fiftieth of an inch in length.

The entire circulation channel is continuously open without a block or break, from the heart, along the arteries, arterioles, capillaries, venoles, veins, the right auricle of the heart, the right ventricle, the pulmonary arteries, pulmonary veins, the left auricle, and back again to the left ventricle.

Arteries are distinguished from veins by their thicker walls, due to a greater development of smooth muscular and elastic tissue. They consist of three walls, the middle coat of the artery being the thickest.

One of the most important properties of the arteries is their contractility, in virtue of which the caliber of the vessel can be varied, and, therefore, the supply of blood to a part can be altered. The amount and tensity of the

contraction depends upon the devlopment of the muscular tissue. If an artery be exposed, it soon contracts under the stimulus of the atmosphere acting upon the muscular fibres. It may also be made to contract by the application of electrical currents. The vaso-motor nerves govern the muscular fibres, and the nerve centers controlling them are in the medulla oblongata.

The blood vessels are elastic and can be distended or elongated, but they rapidly regain their original size and form after the force which causes the distension is removed. When cut across, the walls of the arteries do not collapse, as is the case with the thin-walled veins.

(In referring to tissues, the reader must bear in mind that almost every organ of the body is composed of tissue, as well as the muscles covering them.)

VEINS: The veins consist of three coats, or layers, which are somewhat elastic, but not sufficiently so to make any resistance to pressure upon them. When cut across, they completely collapse.

The walls of the veins have but little power to press the blood forward and to keep it from flowing back there are valves interspersed at various intervals in their course toward the heart. The portal veins, however, have no valves.

The venous system begins, as in the leaves of the trees, as venols; they are the continuation of the capillaries, which serve as a connecting link between the arterioles and the venols. As the leaves and branches of a tree are continuously converging, until finally they form the trunk, similarly the venoles become veins, the veins the ascending and descending venæ cavæ, and there, later, the right auricle of the heart—just one cavity.

It is of utmost importance that the muscular fibre about the veins be kept strong, so that the flow of blood through them be not retarded by muscular pressure. The portal veins, containing no valves, should be especially free from pressure; hence the necessity of maintaining correct poise, so that the organs may be in proper position and not interfere with the portal circulation. Any compression of

the liver interferes with the flow of blood through the portal veins and tends to produce, by retrogressive action, congestion of the lining of the stomach. The liver contains about one-fourth of the blood of the system, and the importance of keeping these cells free will be readily seen.

The heart being situated in the upper part of the body, most of the venous blood must flow upward, and must, therefore, be affected by the force of gravity, which would retard the emptying of the ascending veins. This force of gravity is regulated somewhat by the valves in the veins; and if the position of a limb be up, so that the foot is higher than the thigh, it will aid in the return of blood through the veins to the heart. For this reason, if the circulation be disturbed in the ankle, the foot or the knee, the leg is often suspended so as to aid the return flow.

Aneurism is a condition in which the middle coat of the artery or vein for a very short distance has become weakened, so as to permit the blood pressure to cause a bulging, and, by the pressure increasing, the wall gradually thins until, finally, upon some accidental external pressure, the blood vessel may rupture at this point.

Varicose veins occur in those who, for some cause, have more than normal venous blood pressure, caused by some obstruction of the blood flow in the veins, in which state the muscles of the walls of the veins yield and dilate, causing an enlargement of the veins to such an extent as to distinctly show the venous color of the blood along the whole of the dilated course.

Milk leg is a dropsy of one of the lower extremities. When a particular artery in the pelvis is injured, as by the pressure of the head of the child at birth, causing an inflammation in the wall of the artery, there is a tendency for a blood clot to form at this point. This diminishes the calibre of the vessel to such a degree as to interfere with the normal return of the venous blood from the limb. At the same time there will transude through the walls of the capillaries an unusual amount of lymph, which, gradually increasing, will at last give a marked degree of swelling, known as milk leg. If the obstruction completely plugs the vessel at the injured point, then mortification

will result, extending in some cases to above the knee. This condition, however, is quite rare. Judicious exercise, creating a good circulation, relieves the blood clot, and is the quickest relief.

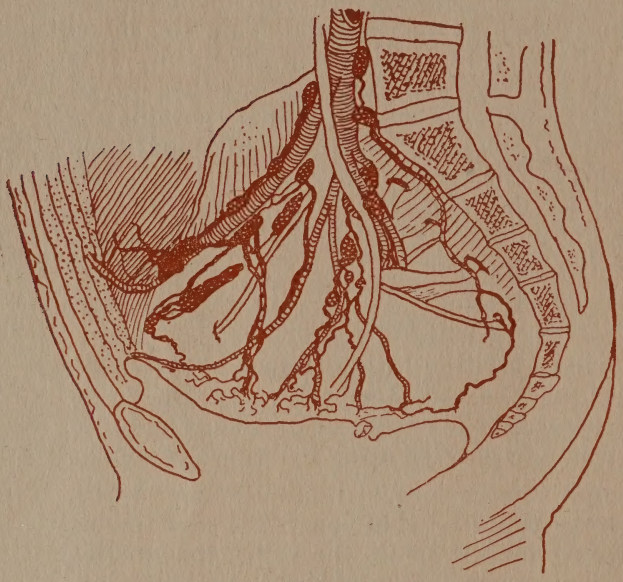
LYMPH AND LYMPHATIC VESSELS: From the blood capillaries there oozes out into the intercellular spaces about them, called lymph spaces, a part of the watery portion of the blood which contains the nutriment and is known as plasma; when it has escaped from the blood stream into the intercellular spaces about the tissues, it is called lymph. Just how this lymph filters or oozes out of the capillary walls is not fully known, but it contains the nutriment elements of the blood necessary to nourish the tissues. It carries to the tissues not only nutrition, but also the inspired oxygen and the raw material, or elements, which the glandular cells use in the preparation of secretions. All of the tissues of the body are moistened by lymph. It is constantly present in all structures, excepting the epidermis, the hair and the nails.

Besides conveying nutrition to the tissues of the body, the lymph spaces are the receptacles for the waste elements of the tissues, and the excess of unused lymph, together with the waste, is carried away by lymph channels.

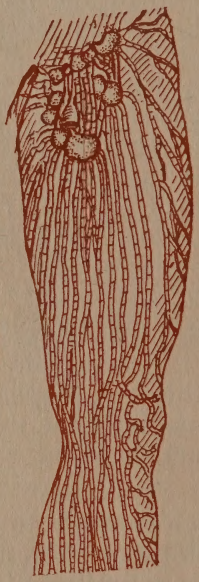
From the lymph spaces proceed minute capillaries, which unite to form tubes or channels. These channels unite or converge somewhat, as do the veins, the smaller ones uniting to form larger ones, and these again uniting, until they finally converge into two trunks, known as the thoracic duct and the right lymphatic duct; these ducts ascend on either side of the spine and empty into the veins at the base of the neck, at the junction of the jugular and subclavian veins. The thoracic duct, which is on the left of the spine, is the larger of the two.

In their course the lymph channels pass through (or rather empty into and begin anew) numerous lymphatic glands, which are a collection of lymph follicles. A large number of these lymphatic glands are microscopic. Others are of fair size, some of them as large as a bean.

In structure the lymph vessels resemble veins and have many valves. The lymphatics from the intestines are called lacteals, and during digestion their content is called chyle. This chyle contains the nutriment elements of the food and is absorbed by the rootlets of the portal veins in the bowels; it is carried to the liver, and thence through the hepatic vein into the blood current. During digestion



Lymphatics of the bladder.

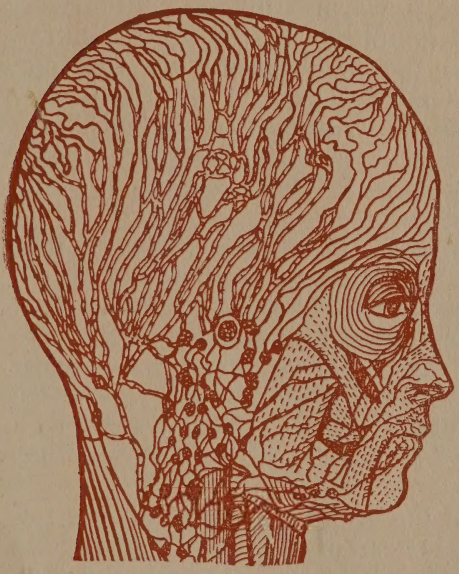


Superficial lymphatics and glands of the internal surface of the limb.

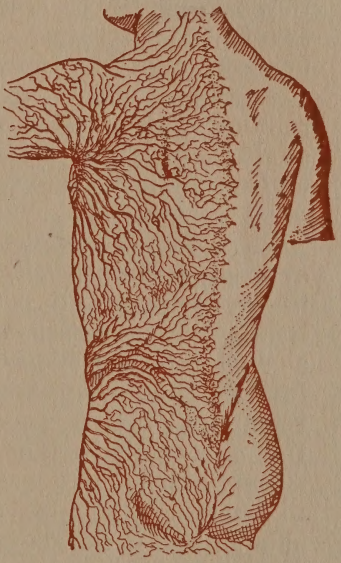
the chyle contains many fatty granules, giving it a whitish appearance, distinguished from the clear, watery contents of other lymphatics. This whitish appearance has given rise to the term lacteal.

Once within the intercellular spaces, the lymph is in easy reach of the substance of the cells. Upon entering the cells, the lymph takes the place left vacant by the removal of their waste products.

The amount of lymph present in the different glands and tissues of the body is variable, the flow of lymph in the liver and bowels being most abundant, indeed, they produce nearly all of the lymph that flows through both lymphatic ducts; that returning from the limbs when in a healthy state is much less. In explaining the difference in the amount of lymph in the different tissues, Starling holds that, since lymph passes with ease through some capillaries and with difficulty through others, there is probably a difference of permeability of the cells of the capillaries in the different areas of the blood-vascular



Lymphatics of the head and neck.



Cutaneous lymphatics of the trunk.

system. A continual interchange is taking place by means of which the nutrition of the tissues is affected, each according to its needs. The lymph contains all the nutriment of the tissues and the material that enters into the various secretions of such glands as the breasts for the production of milk, or the ovaries for the formation of ova. At the same time it is a receptacle for the waste of

the cells. The excess of lymph over and above the needs of the cells, as well as the waste of the cells themselves, is finally emptied into the venous stream at the root of the neck.

The lymph channels are, therefore, the irrigating system, also the great drainage system of the body, and it is of utmost importance that these channels be unobstructed and free for the elimination of waste. This elimination is aided by exercise, by massage and by a thoroughly forceful circulation of blood. More lymph gets into the spaces when there is a high pressure of blood in the capillaries; hence exercise which quickens the circulation sufficiently to create a warmth of the capillaries, favors the filteration of lymph by increasing capillary pressure and thus freeing the blood plasma and causing a larger amount of nourishment to pass out into the intercellular spaces. Since lymph passes out freely and thoroughly nourishes the tissues in rest after exercise, all exercise should be followed by complete relaxation of both mind and body.

Sleep favors complete relaxation of the nerves of the arteries, and consequently the veins, as well as the capillaries, are filled with lymph. The changing process in the lymph cells continues during sleep, though not as actively as during waking hours; thus the sleep period is the most favored time for restoration. During sleep the muscles relax and lymph pours out along their fibres for assimilation, hence the origin of the terse saying: "He who sleeps, dines."

Whether the lymph in the lymph spaces is scanty or abundant, it is the fountain head of life, for it always has in it the nutriment or life-giving elements for the tissues, but it has also to do with death and decay, holding in its solution the poisonous toxins of the body, and when sufficient nourishment is not freed from the blood the poisons are offered to the cells for nutrition.

Should the toxins fail of free elimination, septicemia may ensue. Melancholia, tuberculosis, neurasthenia and similar maladies are dependant upon the quality of the lymph, and anything, therefore, which creates a normal

flow of the lymph, together with the free feeding of nutritious foods, tends to a relief of these maladies.

A congestion of the lymph flow due to a too tense muscular action, which is apt to be the condition wherever the nerves are habitually kept tense, is also a menace to good health. Arterio-sclerosis, which is a hardening of the blood vessels, and Bright's disease, the result of structural changes in the kidneys, are chronic ailments resulting from the congested, or hypertonic state, of the lymph flow. Where there is an undue contraction of the rootlets of the lymph channels there is a hoarding of the toxins, as well as the lymph, and the result is œdema, or swelling.

Where there is a general surfeit of the lymph rich in proteids, as in gout, and the elimination is below par, the oxygen taken in by the lungs is not sufficient to reduce the abundant waste to a fit state for elimination, hence combustion is retarded and incomplete. By virtue of this failure in the combustion process, uric acids and other sub-oxidized products begin to accumulate in the blood stream. Hence, there appears sooner or later, diseases that are very largely due to a too strenuous outpouring of lymph in all persons who are overfed. The necessity of regular exercise and of free breathing in all persons who are over-fed and inclined to gouty condition, so that the waste matter may be readily oxygenized and then eliminated, will be readily seen.*

The lymph spaces may be illustrated by cisterns, each of which is provided with supply pipes—the arteries and the capillaries, while there are two exit pipes—the veins and the lymphatic ducts. In health, the balance between the inflow and the outflow is such that the spaces are merely moistened with fluid. Where there is an undue accumulation of fluid—more or less like serum—in the lymph spaces, we have the condition termed dropsy. If the efferent veins and lymphatics of an organ be ligated or a resistance be offered to the outflow of the blood, congestion and a copious outflow of lymph into the tissues takes place. These are most marked in the skin and the sub-

*Publishers' Note: See Miss Cocroft's lecture upon "Symmetrical Development, Obesity and Leanness."

cutaneous cellular tissue. The soft parts swell up without sign or redness and a doughy swelling, which pits on being pressed with the fingers, results.† These are signs of lymph congestion which is called œdema. The relief from this difficulty is not in applying lotions to the skin, but in quickening the circulation. The failure to carry away the lymph sometimes results, also, in swelling and in local inflammation, such as the hardenous structure at the base of a boil or the swelling of the lower extremities in deep seated erysipelas.

The result of a prolonged retention of waste matter in the lymph spaces not infrequently expresses itself in an abscess; the excess of waste being more than the small lymph channels can carry away is finally broken down by bacteria into pus, and many of the cells of the tissues involved in the diseased parts break down.

It would seem that physicians have not, in times past, given sufficient importance to the free action of lymphatics as agents in the elimination of waste; they are now emphasizing the importance of exercise of every muscle and tissue, that the circulation through arteries, veins and lymphatics may be quickened and all waste of the system be eliminated, as well as the nutrition reach all parts.

THE BLOOD: The blood is the medium of exchange between the outer world and the tissues of the body. The composition of the blood is highly complex. It is produced by the digestive organs operating upon the solid and liquid food taken into the system, together with the oxygen absorbed in the lungs and through the pores of the skin. It is thus an oxygen-carrier and it contains new substances, but in its passage through the tissues it gives up some of these new substances and receives in exchange waste products which are removed from the tissues and carried by the blood to the lungs, to the kidneys, to the intestines and to the skin for elimination. As the composition of the organs through which the blood passes varies, thus the elements in the blood stream must vary

†Publishers' Note: See Miss Cocroft's lecture upon "Aids to Beauty, The Skin, Etc."

in the different parts of the individual under different conditions.

Floating in the blood are the red and white corpuscles. It is the oxygen which gives the bright color to the arterial blood; where oxygen is lacking the blood is dark.

The white blood corpuscles consist of transparent granular-looking protoplasms containing one, two or more nuclei; these nuclei have the power of sending out finger-shaped or filamentous parts of their own substances with which they grapple with foreign bacteria, e. g.: If the tubercular bacilli enter the blood though the lungs, the white blood corpuscles send out their fingers and grapple with them; if the corpuscles be stronger than the bacilli, or bacteria, they squeeze the life out of them, if the bacteria be the stronger they gain the ascendency. The white blood corpuscles have been called the fighters or guards for the system to ward off all foreign bacteria, or if they gain an entrance into the system to destroy them; hence the necessity of keeping up a good vitality and pure blood with a strong current, to enable one to resist disease.

In a normal state, the red corpuscles constitute 45 per cent of the solid matter of the blood. The source of these corpuscles is in the red marrow at the ends of the bones and the cause of their deficiency is to be sought in an impoverished condition of the red bone marrow. They get into the blood stream through the open mouths of the blood vessels from the spaces between the bone cells. Exercise which increases circulation and brings more blood to the periosteum, or covering of the bone, fosters the formation of red blood corpuscles, providing the right foods which produce these corpuscles are fed to the system. In many instances the red bone marrow can be excited to activity by the person taking red bone marrow held in solution in glycerine. Gentle currents of electricity are also regarded as useful means in promoting the formation of both red marrow and bone.

The life of the red blood corpuscles is not known, but it is supposedly very short. The chief function is to convey oxygen from the lungs to the tissues, the oxygen being required to put the waste matter into a state of solu-

tion necessary for elimination. The destruction of these cells takes place mainly in the liver, which breaks down and dissolves the cells as they pass through it in solution into the general current of the blood. Next to the liver in this destroying process is the spleen. The estimated amount of these corpuscles in one cubic millimetre in the male is 5,000,000, and in the female 4,500,000, so that in ten pounds of blood there are about twenty-five billions of corpuscles.

The condition known as anæmia is a state in which the red blood corpuscles are far short of the accustomed number; thus, in this condition the vehicles for carrying oxygen are not adequate and in consequence the combustion of the waste of the tissues is not completed as rapidly as necessary in health; the waste not being fully carried away, the system becomes poisoned.

The food, after being brought into a high state of solution in the stomach and the intestines, is immediately absorbed by the capillaries here situated and carried by the portal veins to the liver, where the blood-making process is continued, and thence into the general circulation through and by means of the ascending vena cava. The mucous membrane of the entire intestinal tract is adapted to absorption, but the greatest area of absorption is undoubtedly in the small intestine, especially its upper half. It is here that nearly all of the fats are absorbed. As the portal blood is passing through the liver* a vegetable starch called glycogen as well as urea, a very important waste product which is eliminated by the kidneys, is formed.

In the adult, the blood constitutes about one-thirteenth part of the weight of the body; in the new born infant about one-nineteenth part. Life is endangered by hemorrhage in proportion to the amount and rapidity of the bleeding. In the adult when one-half of the total blood is lost suddenly, death is liable to result, and in the new-born child when a few ounces are lost. The old, the young and the adipose bear the loss of blood badly.

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*Publishers' Note: See lecture by Miss Susanna Cocroft upon "The Liver, Stomach, Intestines, Kidneys,—Their Use and Abuse."

To restore the number of red corpuscles occasioned by excessive hemorrhage the most important thing first to be done is to supply the loss with some fluid, either salt water or milk. After the blood vessels have received their normal amount of fluid again, the structure of the blood must wait for the production of the corpuscles in the usual way from the food.

The red and the white blood corpuscles play no direct part in nutrition and in a normal state it is only through the capillaries that there is any chance for the watery or nutrient portion of the blood or plasma to pass out from the circulation tube, so that this small part (capillary) of the tube is of great importance in the skin, in the tissues and in the mucous lining of the intestinal tract.

Let us then again trace the circulation of the blood from the heart back to the heart, following its course on the Blood Formation, Absorption and Circulation plate of the Body Manikin, tracing it to the intestines and back to the heart through the lymphatics and veins.

From the left ventricle of the heart (28) the purified, aerated blood enters the aorta (4) where the large branch curves downward (6) in front of the spine; let us follow one branch (11) to the intestines and the further smaller branches (11) or arterioles to the capillaries, which are at the very extremities of the arterioles and are too small to be shown on the chart. At the capillaries the blood channels divide, the impure blood returning to the heart through the veins (22, the blue lines on the chart), through the liver (32), and the veins (23, 19, 18), back into the right auricle of the heart (25).

Blood plasma containing the nourishing qualities oozes out through the capillaries and enters the lymph spaces, where it is returned through the lymph channels (the yellow tubes on the chart), passing through the lymph glands (37), up through the lymphatic duct (29), to enter the venous system at the juncture of the jugular vein (16), and the sub-clavian vein (15), where both the waste of the tissues and the excess of lymph, over and above the needs of the tissues, are again poured into the circulation tube

and enter the right auricle of the heart (25), through the innominate vein (14), and the ascending vena cava (13).

The nourishment from the digestive system is absorbed by the rootlets of the portal veins and carried by the portal veins (20, 22, 23), into the liver (32), and thence through the hepatic vein (19), into the ascending vena cava (18), through the right auricle of the heart (25); from the right auricle of the heart the blood passes into the right ventricle (27), and is sent out to the lungs to be purified through the pulmonary arteries (5), into the capillaries; it is again returned through the pulmonary veins (17), to the left auricle of the heart (26), from which it passes again into the left ventricle (28). The nutrition is again carried to all tissues and the waste is carried to the lungs, to the kidneys, to the intestines and to the skin for elimination.

The circulation of the blood can be traced to the extremities in the same way as shown on the Blood Formation and Circulation Plate, excepting that the lymphatic channels and glands from the extremities are not shown on this plate.

Having shown that the arteries are connected with the veins and the lymphatics by means of the capillaries, the combined capacities of which are about 300 times greater than the arteries, and that all of the blood vessels are continuously open and unblocked through the complete circuit, it remains to show how dependent every part of the body is upon a full and free circulation of the blood, and how intimately this tubular system is associated with every tissue of the body. So close is this relation and so deep the sympathy between the tissues, the blood, and its tubes, that it is scarcely possible for disease to exist anywhere in the body without causing some disturbance in the blood vessels. This fact has led physicians to examine the pulse, for by the force and quality of the pulse the degree of vital stamina, or want of it in any given case, is estimated.

Every secreting organ in an abnormal state, presents some degree of obstruction to the circulation, such, for in-

stance, as torpor of the liver, or a congestion in the venous circulation of the intestines by pressure of any kind.

By understanding the physiological relations of the secreting organs each to the other, it will be readily seen how the obstruction in one will act injuriously on several if not on all the others. When the venous circulation is impeded in the stomach, liver or spleen, or the arterial, in the kidneys and the skin, to attempt to restore the general circulation without restoring it in these important organs, would be as illogical as to attempt to purify a stream while overlooking the impurities at the fountain head. It is impossible to restore a free and equable circulation while the stomach is sluggish, or the liver is congested and obstructs the vena cava, or the sweat glands are occluded, etc.

While such injurious influences are transmitted chiefly through derangement of the nervous system, they are in part—and sometimes in large part—transmitted by diseased blood vessels, a condition which is known as arterio-sclerosis. In such cases there is an undue irritation and tension, accompanied by a diminished calibre of the vessels and but a scanty amount of blood is supplied to the affected area. It is needless to say that without the normal volume of blood, the tissues restricted will be underfed, and the full action of secreting glands cannot be maintained; neither can waste be regularly removed, nor can repair of the tissues be accomplished as in health. Real health demands constant normal action in the several parts of the body in a harmonious and concerted plan.

For growth and strength it is necessary not only to give the body sufficient exercise to keep all of the forces freely active but also to feed it sufficient quantity of the right food, pure air, sunshine and pure water to replenish the waste. It is simply a matter of using intelligence in forming correct habits of eating, drinking, bathing and regular exercise.

The patient will not, as a rule, obey the physician's directions for exercise, and he, therefore, realizes that whatever is done he must do; doctors have, therefore,

relied almost entirely upon medicine as an artificial stimulus to quicken the heart action, so as to create a more forceful circulation, and so as to open up clogged veins or lymphatics, also to thin the blood that it may more easily pass through its channels.

The world is now turning to scientific exercise and massage, directed definitely to strengthening and unifying the circulation throughout the entire body, thus calling undue pressure from the weakened parts, and to establishing habits of full breathing that the body may be fully purified. The intelligent woman is realizing that for retention of health she can do more for herself than medicines can do.

We are marvelously made; if surrounded with fresh air and sunshine and untrammelled by too many clothes, the body will do its work of wasting and rebuilding automatically, leaving the mind and spirit free for development and direction, and the fact that it will do so imperfectly, even though some nerves and muscles be overstrained, while others are cramped and their actions impeded, just as a tree will go on growing though it be bent and scarred, has misled us, or caused us to grow careless; but it remains a scarred, crooked tree to the end.

Before one reaches maturity, each individual should be able to regulate the amount of food necessary to re-supply the waste from the daily chemical changes, to supply sufficient for energy, and should give to the body no more actual food than necessary for this energy and re-supply. One's meals should be alternated with a sufficient amount of exercise to keep up a thoroughly good circulation in the vital organs, so that they may act strongly in the digestive process.*

If the walls of the vital organs be strong, the eliminating and absorbing cells active, so that the juices which aid digestion be secreted in natural quantities, and if judicious care be used in the selection of the proper food in right proportion, the organs will stand much abuse and be strong to throw off waste;—it is long continued abuse, or

*See Miss Cocroft's lecture on "Foods."

continued weakness of nerves and muscles of vital organs which makes chronic invalids.

A few minutes of intelligent care and thought to Nature's requirements each day will save weeks of suffering, and each effort will be more effective. So many drag through the day missing the strong enjoyment of life, while a strong current of good blood, bounding through the veins and arteries, gives vibrant life and jubilant spirits.

Too much emphasis cannot be laid upon a complete, forceful circulation; in speaking of sluggish circulation, reference is usually made to cold hands and cold feet, but forceful circulation through the vital organs is far more important. The average woman puts forth no definite effort to create a good circulation through the stomach, liver, intestines and especially in women, is it necessary to keep good blood, muscular strength and a good circulation about the pelvic organs. A woman thinks she has done her duty by taking a walk, but she can control the circulation of the blood more systematically by five minutes' exercise in her own room, free from the restriction of clothing, than in a five-mile walk. Walking exercises about 68 out of 260 muscles.

The daily work of many people brings into continuous use the arms and legs, calling the blood to the extremities, while with others the work is more mental than physical, and the constant mental concentration calls for an abnormal amount of blood in the brain, which causes a dilation of capillaries; the pressure caused by these dilated cells and the effect upon the nerves, results in the sensation we call tired;—the relief in both cases is in unifying the circulation by calling the excess of blood from the brain or the extremities to all parts of the body. As a rule, we wait for Time to unify the circulation, but the blood can just as well be called uniformly to each muscle and tissue in 15 minutes as to suffer for a number of hours waiting for it to adjust itself.

The effect of exercise upon the stomach, intestines, liver, kidneys and the pelvic organs is to strengthen the muscles of the organs themselves, to awaken a thoroughly

good circulation through the mucous linings, to open and strengthen the cells of the mucous linings of the stomach and the intestines, that the juices which aid in digestion may be freely secreted and absorbed and the nourishment be assimilated.

All exercise sets in motion the mollicules and cells of both the tissues and the liquids of the body, so that the oxygen may more freely circulate about them, and liberate the carbonic acid gas that it may be carried to the lungs for elimination; it creates heat, which aids in the combustion of these mollicules; it quickens the circulation so that oxygen and nutriment are more freely carried to the tissues for better nourishment and their waste is more freely eliminated.

Exercise which definitely reaches the vital organs creates a massage of these organs, it reaches them more effectively than the human hand can do. Every person who would keep in perfect, vibrant health, with a feeling of cleanliness of all of the inner organs, should put regular exercise, working and massaging each vital organ, into the daily program; should know that all waste is freely eliminated from the inner parts of the body just as surely as all dust and dirt is washed from the surface of the body; daily exercise for this cleanliness is as necessary as the daily friction bath is necessary to keep the pores of the skin clean and open. The majority of women and men who are cleanly to a nicety in the care of the surface of the body, neglect utterly the elimination of waste within.

Every housekeeper knows, if she would attend to the healthful conditions of her family, that she must keep the drainage system to her house thoroughly open and clean, and just so, if she would attend to her own health, she must keep the drainage system of her body, including the entire Circulatory System, and the intestines, kidneys, lungs and skin in thorough activity, with no pores clogged and all waste matter consequently entirely relieved. Water running through a clogged drain or sieve trickles slowly but not with sufficient force to cleanse it, and de-

posits, further accumulating, often entirely stop up the drain.

The tissues of the walls of the arteries and of the veins also need exercise for their own strength and growth that they may throw off their own waste.

Dr. Latson says: "The body may be likened to an engine. It must be fed with clear water and this water passed out again in the form of steam—in the changing process from water to steam, energy or power is created and the exhaust pipes must be freely open or in the chemical expanding process of change the pipes weaken and then burst. If water containing dirt or sediments is poured into the engine, the valves become clogged, too much pressure is brought to bear upon the parts leading to the valves, thus weakening them—if mineral water is used, the pipes become corroded and possibly the linings eaten through. Pure water, fed in just sufficient quantity for the machine to handle, offers least resistance, will manufacture regular power and force off its own waste. It is when the engine is over-crowded or the waste is not fully eliminated that the mischief begins.

The difference between the steam engine and the human body is that the body itself is constantly changing, and aside from the waste of the foods taken in, it must eliminate its own waste.

Scientists prove that nine-tenths of the diseases of the flesh are caused by the failure of the system to eliminate its waste."

If the body be given food or medicine which eats into the linings of the digestive organs or clogs the system by useless waste, which it cannot eliminate, as in the case of feeding the steam engine, the parts of the system preceding the point at which the clogging or disturbance occurs are weakened because of overwork. If, in the arteries, at any of the points (11) on the Blood Formation and Absorption plate, there be any impediment, the large artery and all of the branch arteries and capillaries preceding the points (11) at (6) and (8) will be overstrained and weakened because of the effort to dispose of the blood which should pass the natural channels at (11). The tis-

sues in the arteries and capillaries beyond the point (11), will not be thoroughly nourished and will become still further clogged and weakened because the blood is not forced through them with sufficient vigor; the circulation through the venoles and veins at (22), (23) and (18) will be sluggish because not forced past the obstruction at (11) with sufficient strength to collect the waste, to cleanse the walls and to keep open the cells; if it is not forced strongly the arteries and capillaries beyond (11), the lymphatics at (17), and the veins from the intestines will become weakened, by reason of sluggish activity.

Aside from forceful circulation and good blood, health depends largely upon the strength of the nerves. A nervous difficulty rarely originates in the nerves themselves, but is rather brought about by impoverished blood, spinal dislocation and a consequent nerve pressure, by undue blood in the brain, occasioned by excess of mental over physical activity, or by constant pressure of some enlarged organ or tissue upon a particular set of nerves. It will thus be seen how important a part the circulation plays in the strength of the nervous system.*

In the beginning, exercise should not be too rapid; all quick movements call for a too rapid action of the heart to supply the blood to the tissues, and the breathlessness, which many people experience in beginning exercise, or in doing too vigorous work is due to the effort of the heart to supply the tissues with sufficient blood for the rapid movement and the effort of the lungs to supply them with sufficient oxygen. The average person is inclined, in beginning to exercise, to be more or less nervous, and to hold the breath, which causes a gasping in the effort of the system to supply the oxygen; every muscular effort liberates a certain amount of carbonic acid gas and requires a proportionate amount of oxygen for combustion and elimination. One should always rest from this breathless condition before proceeding with the exercise.

Since the plasma of the blood oozes out of the capillaries into the lymph spaces more freely after exercise,

*Publishers' Note: See lecture of Miss Cocroft upon "The Nerves."

and consequent warmth, it is of utmost importance that exercise be followed by complete relaxation, that the tissues may be thoroughly fed, as they dine sumptuously upon the nourishment in relaxation after exercise,—the brain as well as the muscles should let go. All exercise should be so arranged that in one practice period the blood be quickened to every part of the body.

It is especially important that thin people, whose tissues are underfed, completely relax after exercise, and for this reason the period just before retiring is particularly valuable as an exercising period.

In the primitive woman exercise was a necessary part of her daily life. So-called civilization has reversed and transposed the relation between the physical and the mental being; formerly she was an animal with an intellect, modern civilization has made her a soul and an intellect, with an animal residence—indeed some sects even go so far as to deny the reality of the physical residence. In this transposition of the intellect and the effort to cram the brain, the daily exercise and cleanliness of the "inner man" is neglected.

THE LUNGS

BY
SUSANNA COCROFT

The lungs consist of a light spongy tissue which is highly elastic. When the chest is fully opened the lungs collapse, expelling most of the air. As much air remains in the lungs, even after they are removed from the body, a healthy lung floats in water.

In a little child the color of the lungs is rose pink, but they become darker, especially in persons living in a smoky atmosphere.

The function of the lungs (and in part of the skin) is to convey oxygen to the blood, and to remove therefrom carbonic acid gas. The oxygen coming in contact with waste or dead tissue causes combustion and the dead and waste parts of the tissues are thus brought to a state of fineness for elimination through the blood as it passes through the lungs.

The lungs, therefore, are the organs for exchange of waste in the form of carbonic acid gas, for new, pure oxygen.

The thorax, containing the lungs, is conical in shape and practically air-tight, with the small end upward. The ribs spring out from the sides of the spinal column

and the true ribs curving, extend around to join in front with the sternum or breast bone. The floor of the thorax is the upper surface of the diaphragm.

The chest walls are lined with a moist membrane called pleura. This membrane is continuous, lining the upper surface of the diaphragm, then bending up to reach the roots of the lungs or bronchi and is reflected over the entire outside of each lung. The pleura is always moist in health and serves to keep the lungs from friction when they press against the chest-walls as they are distended by inhalation.

The space between the lungs behind the breast bone is called the mediastinum, in the lower half of which is situated the heart.

The different parts of the lungs, beginning in the mouth, are the glottis, or upper rim of the larynx in the back part of the mouth, the lid or epiglottis to close the entrance into the larynx, the larynx about one inch in length with its bulging in front of the neck called Adam's Apple, the trachea or wind-pipe, composed of from 16 to 20 cylindrical, cartilaginous rings, the posterior side of which is flattened and soft and is placed just in front of the œsophagus. The trachea is from four to five and a half inches in length with a diameter from side to side of about three-fourths of an inch. Toward its lower end it comes in close relation with the arch of the aorta and the right pneumogastric and the recurrent laryngeal nerves. The bi-furcation of the trachea into the right and left bronchi is in front of the fourth and in some cases as low down as the sixth dorsal vertebra and commencing above at the lower border of the larynx opposite the sixth cervical vertebra. The length of the larynx is about one inch.

The right bronchus is stout and about one inch in length, the left is more slender with a length of about two inches. Each of these immediately divide into smaller bronchial tubes, which divide again into smaller and smaller bronchioles that finally open into minute pouches. These have thin membraneous partitions extending out from their walls which subdivide them into small vesicles called

alveola, in which are a dense meshwork of blood capillaries.

Food nourishes the body, oxygen relieves the waste.

With each inhalation oxygen passes through the walls of the vesicles and through the walls of the capillaries; as the oxygen passes in, carbonic acid gas escapes, which is breathed out by exhalation. The oxygen passes at once to form a loose union with the iron or coloring matter of the red blood corpuscles, which changes the livid hue of the venous blood to a bright arterial or scarlet hue. This is carried by the pulmonary veins to the left ventricle of the heart and by it sent out through the arteries as oxygenating material for the waste present in the cells of the body as described in an earlier part of this book.

With each inhalation oxygen also enters the pores of the skin and the waste passes out through the pores.

The use of the oxygen inhaled, and its only function, is to attack and reduce the dying parts and waste within the living cells of the body. Oxygen not only passes into the capillaries to eliminate carbonic acid gas, but also oxygenizes or counteracts other substances, such as uric acid, putting it in condition for elimination. Where the system contains an abnormal amount of uric acid, it is lessened in proportion to the amount of oxygen taken into the system through breathing.

Since forty-five per cent of the blood in a normal state is made up of red corpuscles, whose evident purpose is for the combustion of waste and the fact that these red corpuscles must come in contact with the oxygen in order to bring the waste to a state of solution for elimination, it will be readily seen how necessary both the red corpuscles in the blood and the full amount of oxygen be in the removal of waste of the system.

The volume of air taken in at one inhalation by a person of average size is about 30 cubic inches. With a deep and forceful inspiration the same person would take in from 100 to 120 cubic inches. The first or easy in-take is called tidal air; the second, where great effort is made, is called complemental air; when one makes a violent effort at expiration, there will remain in the lungs unexpelled

about 100 cubic inches, which is called residual air. So we have 30 cubic inches of tidal air, 100 cubic inches of complemental air, and 100 cubic inches of residual air.

The two last amounts or 200 cubic inches represent the vital capacity of the lungs and is about the amount of air that is always in the lungs of a living person. At each ordinary inspiration there are taken in 30 cubic inches more and the same amount within a trifle is exhaled at each out breath. The presumption is that the 30 cubic inches that goes out with each exhalation is from the vital capacity air, or 200 cubic inches that had been longest in the air vessels, and, as each inhalation occurs, the air in outermost tubes would be pushed by each recurring inspiration nearer to the air vesicles. This orderly movement of the air in the bronchial tubes, together with its probable prolonged stay in the millions of air vesicles makes it easy for the oxygen to get into the red blood-corpuscles. At the same time that oxygen goes into the blood, there passes out into the air-vesicles carbonic acid gas from the venous blood. Thus the lungs effect the exchange of one gas for another.

When a person is occupying a room the air of which has in it more than 7 per cent of carbonic acid gas, the value of the air for the combustion of tissue waste would be greatly impaired. It is commonly stated that each person needs for proper breathing a room that has the capacity of about 2,000 cubic feet. The necessity of pure air circulating through a sleeping room is most important, as the oxygen is soon taken from the air and the poisonous carbonic acid gas thrown off which is again breathed into the lungs.

The highest oxygen pressure is in the lungs and its lowest is in the tissues where it is used up in burning the waste of the cells. The highest pressure of carbonic acid gas is in the tissues where combustion and work is going on, and the least is in the lungs. These two gases move along the lines of least resistance, the oxygen along with the red corpuscles down to the capillaries where it escapes into the lymph and the carbonic acid gas from the muscles (for it is in them the great bulk of the oxygen is chem-

ically united with the waste) and passes up and out to the lungs along with the venous blood for removal.

BREATHING: In inhalation the entire rib cage spreads outward, as illustrated by the dotted lines of Figure I, and as it spreads outward there is a very slight raising of the thorax, while the diaphragm, which is the strong, fan-shaped group of muscles forming a partition which separates the lungs and the heart from the stomach, the kidneys and the spleen, contracts and spreads downward

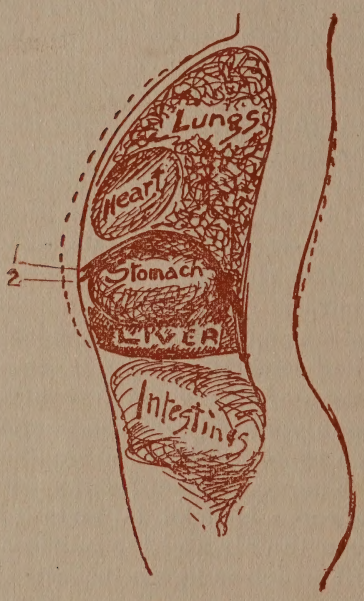

FIGURE I.
(1) Normal position of diaphragm.
(2) Position of diaphragm in inhalation in diaphragmatic breathing.

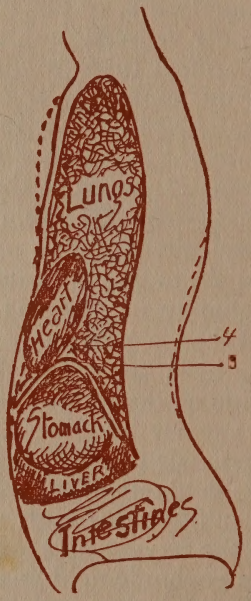

FIGURE II.
(3) Habitual position of diaphragm in a figure who stands in this attitude.
(4) Position of diaphragm during inhalation in intercostal breathing.

(see Figure I) compressing the stomach, the liver and the spleen; thus each inhalation in deep, correct breathing gives these organs their natural, physical exercise. In exhalation the diaphragm relaxes and slides upward as shown by Figure I.

As stated above, with a long, full complemental breath

the capacity of the lungs is doubled. If the chest be contracted, as much of the air as possible being expelled from the lungs, and if a tape line is put around the body over the shoulder blades under the armpits, and the number of inches noted, and then the tape line be held in the same position until the lungs are fully expanded, taking in as much air as possible, the difference between the circumference of the contracted measurement about the chest and the expanded measurement in a person of normal size will be from three and one-half to four inches; if a tape line be placed around the body about three inches above the waist and the air be expelled from the lungs, then the lungs be filled to their fullest capacity, the tape line remaining in the same position, the difference between the contracted and expanded diaphragm will be the same as the difference between the contracted and expanded chest measurements.

In the manner of breathing of the average woman, instead of the diaphragm contracting and lowering and the measurement about the diaphragm increasing with inhalation, as illustrated above, the shoulders are raised, the chest is lifted, and the back drawn in as shown by the dotted lines of Figure II, and the diaphragm drawn still farther upward (see 4 Figure II); as the chest lifts, the measurement about the diaphragm in the inhalation is smaller than in relaxation.

This manner of breathing has doubtless come from restrictions of dress. The effort of inhalation should be to increase the capacity of the entire rib cavity and the breathing should be diaphragmatic, rather than intercostal. The average woman has little or no control of the muscles about the diaphragm, while these muscles should be as strong as those of the arms or the legs.

In taking long breaths, as a breathing exercise, if the hands are placed upon the hips there will be less interference with the expansion of the rib cage.

In the inhalation the mouth should be closed and the air drawn in through the nostrils. The hairs in the nostrils ensnare particles of dust in the air; the membranes

of the nostrils detect noxious odors and warm and moisten the air before it enters the lungs.

In the intercostal breathing it is impossible to expand the lungs to their fullest extent and to take in the necessary amount of oxygen for the system. The effort of Nature to supply this necessary oxygen with these inadequate breaths, especially where too much fat is packed about the lungs and heart, causes quick, short breaths; the average woman breathes about 22 times a minute; by creating a habit of deep breathing this can be retarded to from 12 to 16 times a minute.

The frequency of respiration depends upon age, sex and the state of the emotions. In youth we breathe more frequently than in middle age. And in emotion we breathe now shallower, now deeper, as in sobbing. Physiologists have gathered from various sources the rates of breathing in several species of animals:

The horse breathes from 6 to 10 times per minute, the rat 100 to 200 times per minute, man from 16 to 20, the pig, next to him, 15 to 20, and next nearest is the sheep, from 12 to 20 times per minute. The new-born babe breathes, in some cases, as high as 70 times per minute, an adult between 30 and 50 years 23 times, while from one year to five, the infant breathes 32 times.

Coughing is a violent expiratory act. We first take a deep inspiration and then by suddenly contracting the accessory respiratory muscles, the diaphragm being relaxed, the air is drawn out through the glottis with great force.

A hiccough is a sudden contraction (depression) of the diaphragm, with the glottis closed by the epiglottis being clapped down upon it. When the in-rush of air strikes the epiglottis the characteristic sound is the result.

A sigh is effected by a deep and slow inspiration, followed by a prolonged expiration. Sniffing is a series of quick repetitions of short, snappy insipiations.

Because of sluggish circulation and because of lack of free use of the lungs, occasioned by weakened or cramped muscles, lung cells become weakened and some-

times the extremities of the lungs become entirely closed. The breathing muscles should be kept strong, the rib cage, which in the average mature person is allowed to settle, should be expanded, lifted and kept flexible, so that each lung cell may fully expand, then the lung tissue, by constant exercise, will expand.

Each movement of the diaphragm is a natural and required physical exercise for the stomach, the liver, the kidneys, the spleen and the pancreas, and when lungs and diaphragm are not rightly used these organs are not fully and constantly exercised.

It is just as easy to establish correct breathing habits as incorrect ones—just as easy to use the entire lung as part of it.

By comparing Figures I and II it will be seen that the capacity of lungs and heart is decreased fully one-half.

The lungs of each individual are of a relative size compared with the other organs of the body, to take in, if not cramped in any way, sufficient oxygen to eliminate all waste. If the air be pure and the circulation of the blood be normal, sufficient red corpuscles will pass through the lungs and sufficient oxygen will be supplied for the elimination of all waste; but the measurements of 15,000 women show that the average woman uses less than two-thirds of her lung capacity. Is it not safe to say that the blood, as it passes through the lungs is about two-thirds purified—that it absorbs but two-thirds of the oxygen necessary for oxygenizing gases, for elimination, that the blood but two-thirds purified is returned on its course from the heart to the extremities and back again to the heart, and being already impregnated with impurities will not thoroughly collect those on its course, and the system becomes poisoned with its own gases?

Consumption is not inherited. In all cases where the lung capacity is diminished either by compression of the rib cage or by habits of incorrect and incomplete breathing, there is a diminution in the capacity of the bronchial arteries (the arteries that pass from the arch of the aorta to the two bronchi for the purpose of furnishing the lungs themselves with nutritional

blood) and it is now believed that any incurability of consumption is largely due to the inadequacy of the bronchial arteries, so that sufficient nutriment is not carried to the lungs themselves as well as the failure of the white corpuscles of the blood to kill the bacteria. The tubercular germ multiplies slowly and if the blood be strengthened, the breathing be regulated, and plenty of pure air be taken into the system, consumption, if taken before the bacteria have gained the ascendency, is cured. Thus, physicians rely more upon building up the general vitality of the individual, getting pure, strong blood, a thorough flexibility of the rib cage so as to admit of full, regular breathing, that the blood may be kept pure and freely circulating through the lungs, so as to fully nourish the tissues of the lungs themselves. If all of the lung tissues be kept fully exercised by deep breathing and the blood be kept in a normal state, there is little danger of consumption. It is not inherited; one may possibly inherit a tendency to weak lungs so that the tubercular bacilli upon entering the system would find slight resistance, but the lungs can be strengthened.

Owing to the difficulty of accelerating the circulation of the blood in the bronchial arteries, when sluggish or if retarded or when too forceful, physicians are also becoming very pessimistic as to the value of drugs in the treatment of pneumonia.

In order also to keep the strength of the lungs as of every other vital organ, the nerve centers controlling the lungs must be kept strong, and while the medulla oblongata, which is the seat of these nerve centers, and has been called the "vital knot," cannot be definitely reached by the fingers in massage, or by exercise, it is reached by free exercise of the spinal cord.

The rhythmical action of respiration is dependent upon the medulla oblongata. The stimulus that excites this nerve center to act is the carbonic acid gas that comes to it in the blood. When this is in excess, the respiratory efforts are excessive, and when not, they are regular.

The nerves that conduct the commands of the breath-

ing center in the medulla oblongata, to increase respiratory activity, are the two pneumogastrics, otherwise known as the tenth pair of cranial nerves. Those that promote and bring about expiratory efforts are the prenic nerves that go to the diaphragm, a few fibers in the pneumogastrics and certain of the spinal nerves that go to accessory muscles of respiration. The influence of the olfactory and abdominal nerves upon respiration and cold water on the back of the neck are more fully considered in the lecture upon the Nervous System.

As an illustration of the effect of the nerves upon the manner of breathing, it will be noted that in a peaceful state of mind the individual naturally breathes slowly, deeply and rhythmically; in excessive joy more rapidly, while in the case of fear the breathing becomes rapid, short and sometimes almost stops. If one is in an agitated, disturbed state of mind and goes out into the open air, practicing deep, slow, rhythmic breathing, this rythm reacts upon the mind and tends to produce the state of mind of which the manner of breathing is expressive. Ancients, realizing this relation and this reflex action of the body upon the mind, give definite, dynamic breathing exercises to reinstate a normal mental poise.**

**See lecture upon "Mental Poise."

LECTURES *by* SUSANNA COCROFT

GROWTH IN SILENCE

"Enter into thine inner chamber and shut the door."
"There is a divine sequence, a golden thread running through the lives of all men and women of truly great and lasting power."—R. W. TRINE.

A GOOD FIGURE—PHYSICAL POISE—(Illustrated)

"Style is in the carriage, not in the gown."
"No woman is to blame for not being beautiful at sixteen, but she has only herself to blame if she is not beautiful at forty."—FRA LIPPO.
"Few women know how to stand, to sit or to walk without undue expenditure of nerve force."

IDEALS AND PRIVILEGES OF WOMAN

"The normal woman is happy if well."
"Her first duty is to herself. To be a good mother she must first be a perfect woman."
"She has not only her rights as a true woman, but the devoted homage and service of man."

THE CIRCULATORY SYSTEM—Heart, Lungs, Arteries, Veins, Lymphatics and Blood

Miss Cocroft has spent years in the practical study of anatomy and physiology. This lecture follows the blood from the heart on its complete circuit of the body back to the heart—showing the dangers and results of sluggish and of impure blood flow, with resultant physical ailments and their relief. No student of physiology should be without it.

BODY MANIKIN AND POSITION OF VITAL ORGANS

The body manikin with but few additions is sold to physicians for $15.00. This manikin is printed in seven colors and includes fourteen different plates, showing the muscles, blood vessels, nervous system, the organs of respiration, digestion and all other vital organs, each in its exact relation to the other. It enables a woman to look within her *physical self* and to understand the many facts about herself which Miss Cocroft explains in her lessons—facts which every woman, wife and mother should know—facts which it is a sin for her not to know.

CHARACTER—As Expressed in the Body—(Illustrated)

"How can I hear what you say when what you are is forever thundering in my ears."—EMERSON.
True grace is visible expression of graciousness.
Grace, womanly dignity, self control, ease of manner, laziness, indifference, lack of energy and ambition, moral weakness, or moral courage, each has its expression. Not only how to thus read character, but how women can best express it in herself is the theme of this address.
"The secret of the highest power is in uniting the outer agencies of expression with the power that works from within.

MENTAL POISE—SELF-SUFFICIENCY and THE NERVOUS SYSTEM

Many of woman's physical ills are traceable to shattered nerves, and many such ills yield with astonishing readiness to the influence of a rightly directed mind. How and when to thus treat the physical by the mental is told in this lecture, which also includes a clear description of the nervous system, its functions and its influence upon the various parts of the body.
"The great man is he who, in the midst of a crowd, can keep with perfect sweetness the serenity of solitude."—EMERSON.

EFFECT OF HABIT UPON LIFE—FOODS

Habit is a marvelous gift of nature. Rightly used, it lengthens life and is a great conserver of energy. Wrongly developed habit is a check to growth. Habits of eating greatly influence health and these are treated in the chapter about Foods.

MOTHERHOOD

The life, the vitality, the mental capacity, the moral character of the child depend directly upon the strength, the character, the mental attitude of the mother. Motherhood is woman's most sacred privilege and the true mother finds greatest joy in fitting herself to fulfill that privilege in the most beautiful way. How woman may best equip herself for motherhood and how the mother may preserve herself and prolong her usefulness to her children, is clearly set forth in this lecture.

THE VITAL ORGANS—Liver, Stomach, Intestines, Kidneys—their Use and Abuse

The whole treatise is so lucid and so simply told that all can perfectly understand it, and the body manikin shows the organs referred to and renders the explanations absolutely clear. This lecture is full of practical, everyday health hints.

AIDS TO BEAUTY—Skin, Hair, Eyes, Teeth, Hands, Feet and Ears

Life is made up of little things—and so is beauty. No woman can be truly beautiful or wholesome who neglects the details of her toilet. Indeed, these little things are a constant index of character. This lecture gives many health and beauty hints which some women have paid hundreds of dollars to learn.

SYMMETRICAL DEVELOPMENT—Obesity, Leanness

Miss Cocroft in her physical culture work has had a most remarkable opportunity for studying the causes of obesity and leanness, and has been wonderfully successful in correcting these faults and rounding out or diminishing until the figure resumed its natural proportions of grace and symmetry, to the comfort and delight of her pupils. Her suggestions on these subjects are full of interest and value to every woman.

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